AbstractID: 12691 Title: Characterization of kilovoltage x-ray spectra using measurements with a high-purity germanium detector and Monte Carlo simulations

Purpose: Photon spectra of a COMET MXR-320/26 x-ray tube were measured and corrected for the detector response calculated using Monte Carlo (MC) simulations. Measured (corrected) spectra were compared to spectra from BEAM/FLURZnrc simulations, SpekCalc, and Gesellschaft für Strahlen-und Umweltforschung mbH München (GSF) Report 560.

Methods and Materials: Several NIST-traceable x-ray beams ranging from 20 kVp to 250 kVp were measured with a high-purity germanium detector. The detector was positioned 4.3 m from the focal spot of the tube along the central axis. Pinhole collimation reduced the fluence rates to measurable levels using a tube current of 1 mA. . The entire measurement apparatus was modeled using the MCNP5 MC code. A detector response function was calculated from the model, and the measured spectra were corrected for detector response. The SpekCalc program [Poludniowski et al., Phys. Med. Biol., 54, N433–N438, 2009] was used to generate spectra. The full model of the x-ray tube was used to simulate spectra with the BEAMnrc and FLURZnrc MC codes. The measured (corrected), calculated and GSF spectra were compared.

Results: The measured (corrected) spectra of this investigation generally compare well with those from the BEAMnrc/FLURZnrc simulations, as well as with those generated with the SpekCalc program and from GSF. Differences in the various spectra, particularly in the abundance of W L-shell fluorescence for the lower energy beams, are largely due to the physics of the programs or codes being used.

Conclusions: X-ray beam measurements using novel correction methods for bremsstrahlung spectra, as well as simulations of the full x-ray tube geometry, were presented. This direct comparison benchmarks the MC and analytical methods commonly used for x-ray beam characterization against physical measurements and reveals some of the subtle differences in the various calculation methods.